



ENVIRONMENTAL SHOW OF THE SOUTH APRIL 21, 2016

ADVANTAGES OF DRY ANAEROBIC DIGESTION



Zero Waste Energy Expertise

ZWE's dry anaerobic digestion systems are turning **organic waste** into renewable **energy**.
We are doing this **now**. No other technology provider can offer these **results**.



Monterey Regional Waste Management District, Marina, CA
SSO Dry Anaerobic Digestion to CHP



Blue Line Transfer/SSF Scavengers, South San Francisco, CA
SSO Dry Anaerobic Digestion to CNG



Zero Waste Energy Development Co., San Jose, CA
OFMSW + SSO Dry Anaerobic Digestion to CHP



What's next.



Organics Processing Drivers

- **Tipping Fees**
- **Landfill Capacity**
- **Waste Stream**
 - Quality and Quantity
 - Collection Method
- **Transportation Costs**
- **Marketability of Commodities**
 - Biogas Use
 - Compost market
 - Fuel replacement economics
- **Community and Political Influences**
- **Competitive Landscape**



What's next.



The Final Frontier

Recycling's 'Final Frontier': The Composting of Food Waste

A move by New York City to begin collecting food scraps and other organic waste is just the latest example of expanding efforts by municipalities worldwide to recycle large quantities of unused food and slash the amount of material sent to landfills.

BY DAVE LEVITAN

As municipal food composting programs spread across North America and Europe, no city faces a more daunting task than New York. Its Department of Sanitation collects more than 10,000 tons of trash every day, and another 1,700 tons of recyclable materials. A large portion of that waste, though, may soon have a future other than the landfill: Food scraps and other “organics” have long been just a part of New York’s trash pile, but a pilot program in the city is aimed at rolling out collection of that material and composting it, a far more environmentally friendly method.

“It’s the next new thing in terms of municipal waste handling in the 21st century,” says Eric Goldstein, a senior attorney with the Natural Resources Defense Council (NRDC) in New York. “Right now... there are over 150 communities throughout the United States that are collecting organics at curbside. It’s a national trend. It’s revolutionary.”



What's next.



EPA Moves to Slash Methane at Landfills and Oil Wells

Published: July 2nd, 2014



By Bobby Magill

The federal government is proposing several small steps to reduce climate change-driving methane emissions in the U.S. — one related to landfills and the other to oil and gas wells on Native American reservations.

As part of the Obama administration’s [Climate Action Plan](#), the U.S. Environmental Protection Agency [announced Tuesday](#) that it is proposing to improve its air pollution standards for newly-built municipal landfills, requiring them to capture landfill gas, which contains methane and carbon dioxide.



Landfill in Danbury, Conn.
Credit: United Nations Photo/flickr

The EPA estimates that methane accounts for about 9 percent of greenhouse gas emissions in the U.S. Landfills are the third-largest source of methane emitted by humans in the U.S. behind oil and gas production, and livestock. Over a 100-year timeframe, methane is about 34 times as potent at trapping heat than carbon dioxide, and over 20 years, it’s **86 times more potent**.

The new rule would cap municipal landfill emissions at a lower level than currently required. New landfills would be required to capture two-thirds of their methane and toxic air

emissions by 2023, or about 13 percent more emissions than required under current regulations.

The EPA also announced that it is considering an update of emissions guidelines for existing landfills nationwide as a way to reduce methane emissions. Those guidelines, if implemented, would affect more than 1,000 landfills across the country.

In a statement, EPA administrator Gina McCarthy said reducing methane is a powerful way to act on climate change, building on the the Obama administration’s progress in addressing climate change.

Banning Organics from Landfill

- Regulations and Municipal Initiatives are driving organic material handling in the U.S.
- Since 2011, many states such as Connecticut, Vermont, Massachusetts have instituted food waste bans from landfill for certain large commercial food waste generators
- Cities such as Seattle, San Francisco, New York City and Portland have instituted food waste bans for certain food waste generators



What's next.



Environmental Attributes

- **Investment Tax Credit** – Up to 30% tax credit on qualified purchases of renewable energy property
- **Renewable Identification Number (RINs)** – Federal program that provides cash credits of \$.75 to \$1.50 per gallon of renewable fuel produced
- **Renewable Energy Credits (RECs)** - \$.02 to \$.07/kwh for production of renewable electricity
- **Low Carbon Fuel Standards (LCFS)** – California program that provides cash credits of \$.25 to \$1.00 per gallon of renewable fuel produced



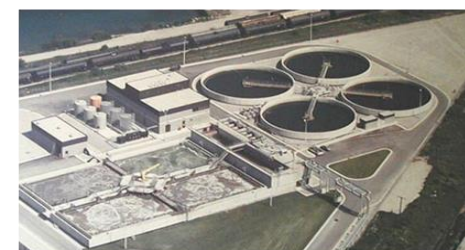
What's next.



Basics on Anaerobic Digestion

- Solids Content- High or Low Solids
 - Waste Water Treatment are Low Solids or “Wet” systems (Pumpable)
 - Municipal Solid Waste is considered High Solids or Dry (Stackable)
- Source of Feedstock, Collection Method and Contamination
 - Pre or Post Consumer
 - “In a Pipe” or “In a Truck” and type of truck and container
 - Levels of Contamination and effect on AD process
- Placement into “Eco System”
 - Supporting Infrastructure
 - Siting and co-location
 - Integration with composting
- Processing Costs and Total System Costs
 - System and integration costs
 - Water balance and treatment

Industrial Waste to
Waste Water Treatment Plants



Bio-Industrial Park Sarnia

Wet Digesters



Harvest Energy Gardens

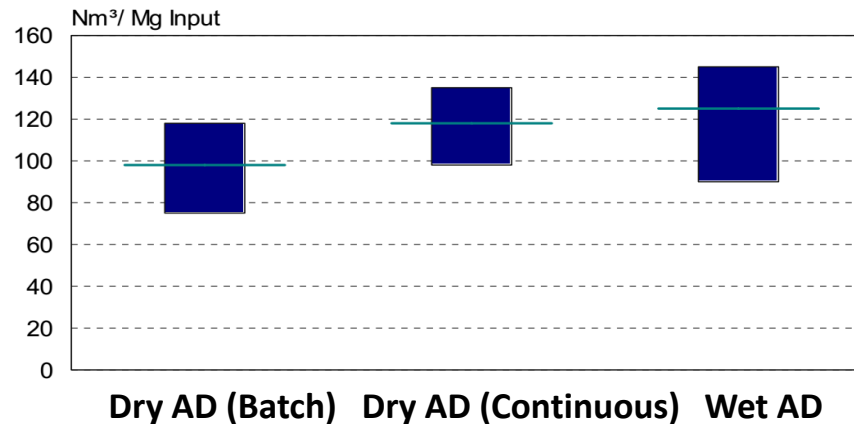


What's next.

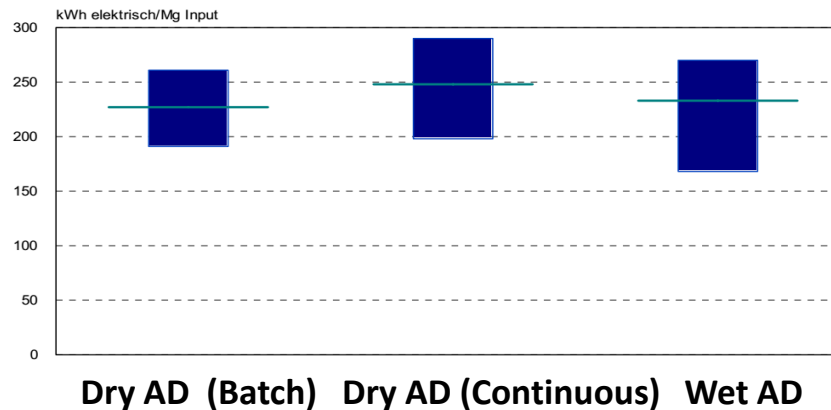


Dry vs. Wet Anaerobic Digestion of Organics

Specific Biogas Yield per MT Input



Specific Net Electric Power Yield per MT Input



Datengrundlage: Herstellerangaben 2008 und eigene Berechnungen

Witzenhausen-Institut 2008



What's next.



Anaerobic Digestion Trends

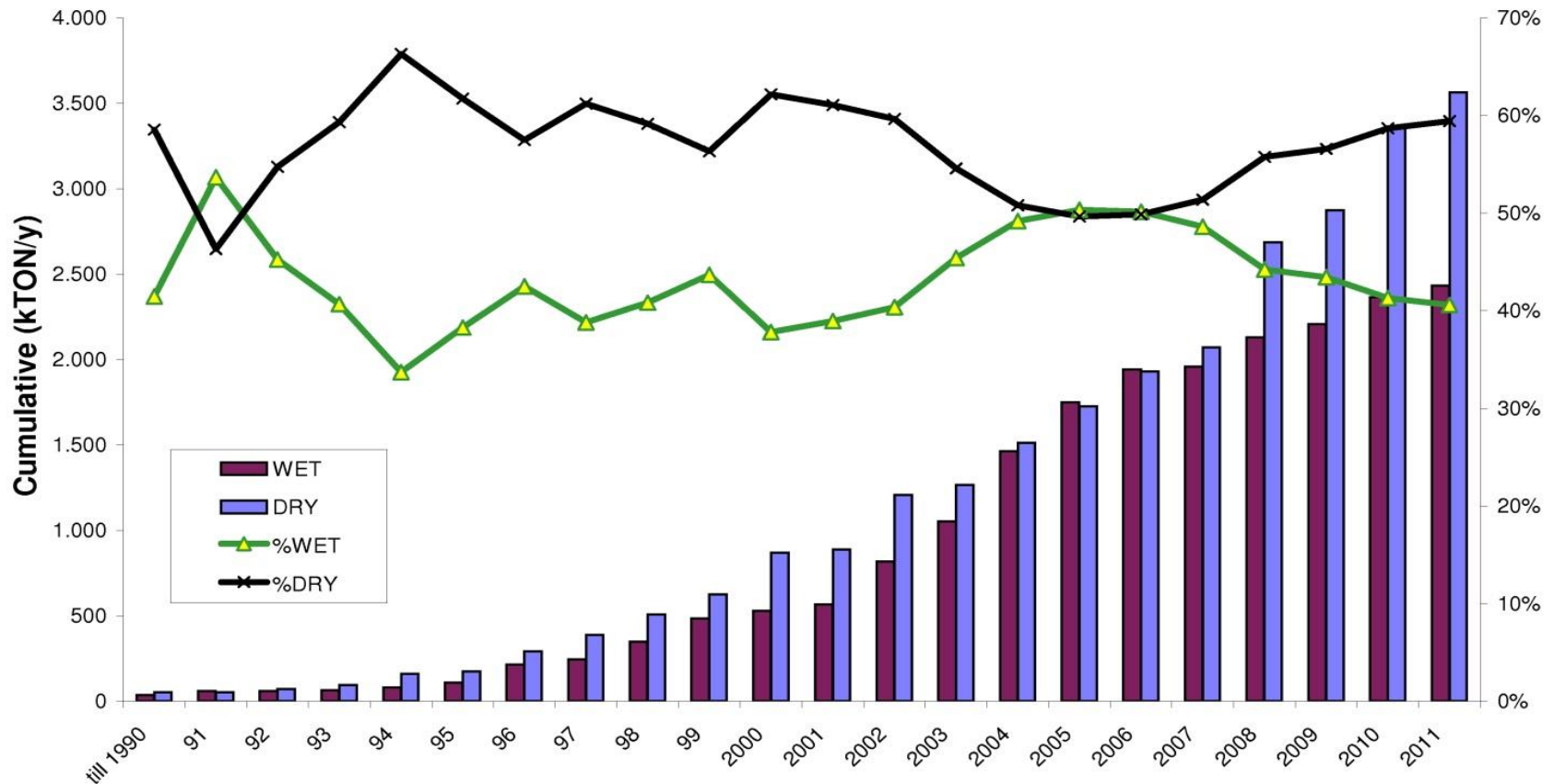


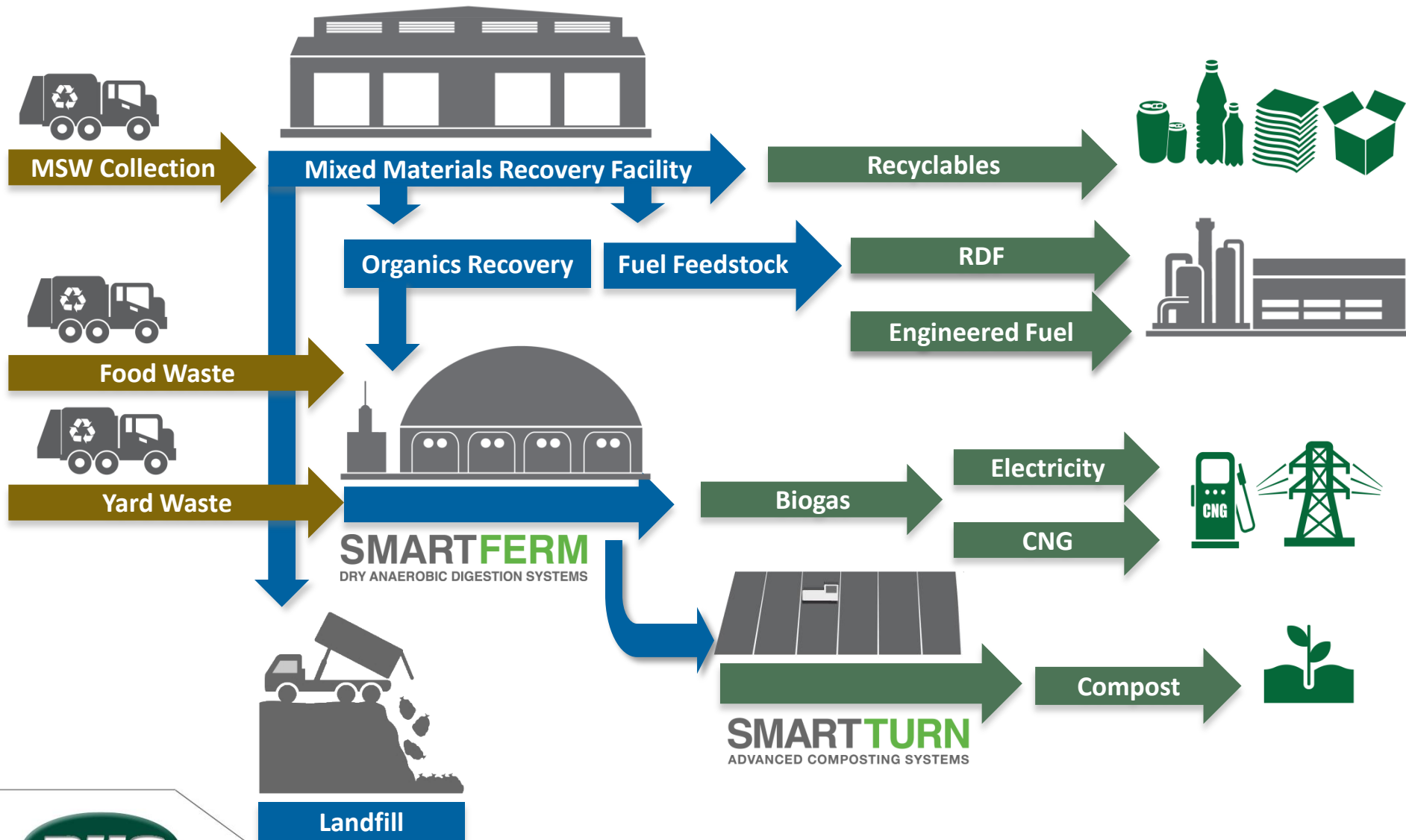
Figure - Wet vs. Dry Digestion for SSO and OFMSW in Europe [Source: De Beare and Mattheuws, BioCycle Journal, Feb. 2010]



What's next.



Integrated Waste Management Model



What's next.



Advantages of Dry Anaerobic Digestion

- Technology specifically designed and optimized to process solid waste:
 - Food waste, organic fraction of MSW (OFMSW) and green waste
 - Inorganic and inert materials are generally acceptable
 - Shredding/size reduction not required
- Dry Anaerobic Digestion introduces the process to the waste rather than the waste to the process
 - No direct mechanical contact with waste which minimizes equipment downtime and electrical consumption
- Process is engineered to optimize the trade-off between biogas production (i.e., carbon depletion) with quality and cost-effective compost production
- Multiple digester batch process maximizes system availability and normalizes biogas production

Technology Overview: Dry Anaerobic Digestion

- Complete dry fermentation AD System – 21 day digestion cycle
- Biogas economically converted to electricity, heat and/or transportation fuels (CNG)
- Option for in-vessel composting for ammonia scrub or compost maturation
- **SMARTFARM** offers two platforms: prefabricated steel and cast-in-place concrete digester platforms (5,000 – 100,000 TPY with 4 to 18 digesters)



What's next.



SMARTFERM Feedstock

Acceptable Materials

- Food waste, organic fraction of MSW (OFMSW) and green waste. Inorganic and inert materials are generally acceptable, Shredding/size reduction not required.
- Wide range of food waste / green waste
 - 20/80 either way
 - Accommodates seasonal variations
- Need to consider *stacking*



What's next.



5,000 TPY Biogas to CHP

First U.S. SMARTFERM Project

Monterey Regional Waste
Management District
Marina, CA
Opened February 2013



Process	Results
Annual Volume (TPY)	5,000
Digester Dimensions	40' (L) x 12' (W)
Steel Digesters	4
Residence Time	21 Days
Mode of Operation	Thermophilic (125-131°F)
Biogas Yield (CF/Ton)	3,000 – 3,200
Methane Content (%)	58 - 65
Electrical Output	100 kW
Finished Compost @ 40% MC (TPY)	2,200



What's next.





What's next.





What's next.



90,000 TPY Organic Waste Conversion to CHP



Zero Waste Energy Development San Jose, CA Commissioned November, 2013

Process	Results
Annual Volume (TPY)	90,000
Digester Dimensions	97' (L) x 18.2' (W)
Digesters	16
Residence Time	21 Days
Mode of Operation	Thermophilic (125-131°F)
Biogas Yield (CF/Ton)	3,000-3,200
Methane Content (%)	58-62
Electrical Output	1.6 MW
Finished Compost @ 40% MC (TPY)	34,000
Total Diversion	+84.5%



What's next.





What's next.



ZWEDC – City of San Jose: Organics

Before

- ✓ 100% organics to landfill
- ✓ No energy generated
- ✓ No compost generated



After

- ✓ 100% organics diversion
- ✓ 1.6 MW electricity produced
- ✓ 35,000 TPY compost used for land applications



Blue Line Biogenic CNG Facility: Organics



BLUE LINE
TRANSFER, INC.

Location: South San Francisco, California
Commissioned: 2015
Type: SSO + Organic Fraction of MSW
Tonnage: 11,200



Notable:

- First closed cycle project of its type in US
- Fuels approximately 18 of Blue Line's CNG collection vehicles
- Each collection vehicle collects enough organic waste during just one route to fuel it for an entire day



What's next.





What's next.





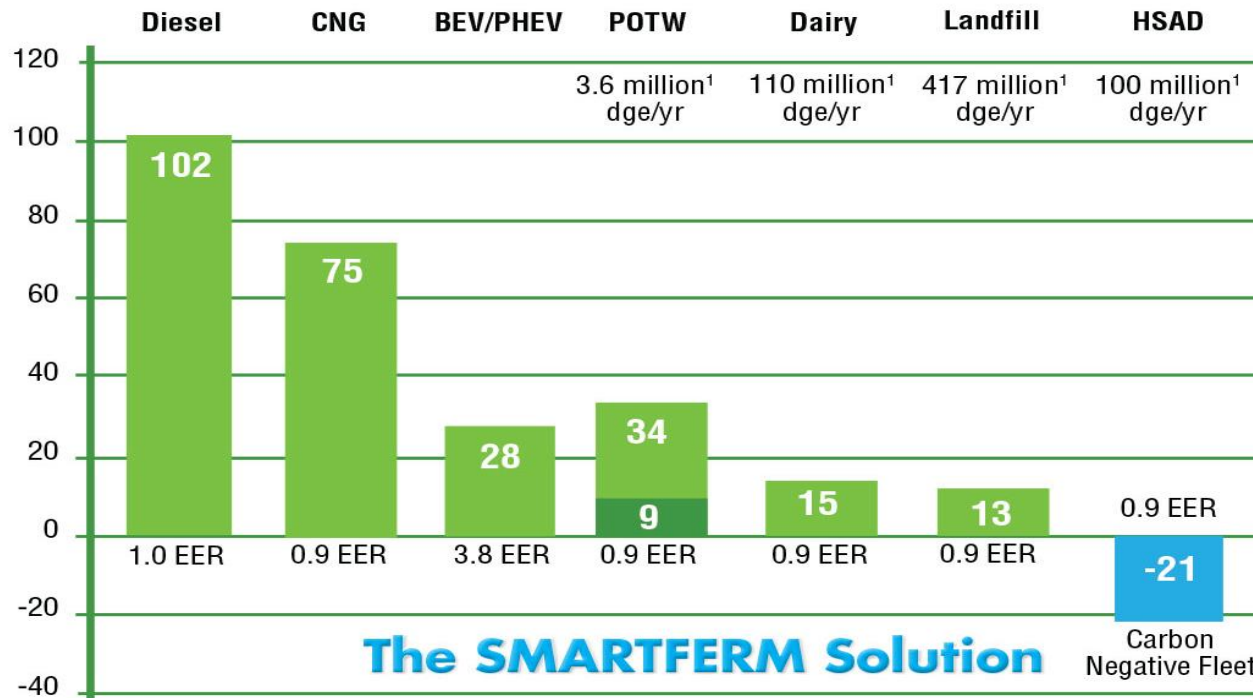
What's next.



Zero Waste Energy Carbon Negative Fleets



**Carbon Intensity for Diesel & Substitutes,
grams CO2 emitted per unit of energy adjusted for energy (g CO2 e/MJ)**



¹ UC Davis

(Information provided by: California Air Resources Board & the Edgar Institute)



What's next.



Biogenic CNG Fuel Facility: Organics

Before

- ✓ 11,200 TPY Organic waste to landfill
- ✓ \$100 per ton disposal fees

After

- ✓ 120,000 DGE CNG Fuel +
- ✓ 43% reduction in emissions from vehicle fleet by 2022
- ✓ No disposal fees



What's next.



ZWE Difference

Systems & approaches that generate a **solid return on investment**

Technology **built in the US** specifically for the Waste Industry

US Operating References for all size operations

Best partner with **experience, resources, & technologies to execute**

Flexible approaches from design – build to own-operate



What's next.



The logo features a green circular icon with a stylized swirl at the top. Below it, the text "ZeroWaste" is written in a large, green, sans-serif font, with a trademark symbol (TM) to the right. Underneath "ZeroWaste", the words "ENERGY, LLC." are written in a smaller, green, all-caps, sans-serif font.

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What's next.

